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CRUCIBLES
their care and use

by

JOHN A. WALKER

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CRUCIBLES

THEIR CARE AND USE

THE purpose of this book is to inform the user of crucibles as to their nature and characteristics, and give him suggestions as to their care and handling, which, if followed, will add to their efficiency and greatly prolong their period of usefulness.

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Published by the

JOSEPH DIXON CRUCIBLE COMPANY

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MANY foundrymen do not fully appreciate the importance of keeping and handling their crucibles in a manner which will insure the greatest number of heats with the least danger of accidents, and this booklet is published to emphasize this point.

The importance of the subject seems to be underestimated, and crucible users will find it to their advantage to give the matter more thought and attention, and instruct their furnace men, melters and other employees accordingly.

The graphite crucible (graphite is otherwise known as plumbago or black lead) is now in almost universal use, having supplanted the clay crucible, which, though comparatively inexpensive, lasted only a heat or two, and was exceedingly unreliable. Even the graphite crucible, the most efficient melting pot yet invented or likely to be invented, is necessarily a fragile and delicate thing. It is expected to withstand successfully degrees of heat sufficient to melt the most refractory metals, from composition to nickel, and no known vessel can long withstand such savage punishment.

As any defect in, or accident to, a crucible is an exceedingly annoying as well as an expensive matter, and as such occurrences are in most cases due to improper or careless methods in the annealing or handling of crucibles, the suggestions embodied in this booklet should prove valuable, as they are the result of long experience and the best thought and knowledge on the subject.

Graphite, what it is and why crucibles are made of it

Graphite is a pure carbon and belongs to the diamond and coal family. It is the product of a temperature beyond the limits of calculation, and is found in the oldest rock formations.

The fact that it is the result of incalculable heat, of course enables it to bear up under degrees of heat that will melt other minerals.

Graphite is found in limited quantities all over the globe, but only in a few locations is it in sufficient volume to pay for mining and refining.

In making crucibles there is added to the graphite sufficient clay to furnish the necessary binding qualities which graphite lacks, and fire-sand to give the crucible openness of grain, thus rendering it able to withstand sudden changes in temperature.

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The quality of graphite for making crucibles is important. It must be of the foliated variety which gives it a perfect basal cleavage, the thin lamina when separated being flexible but not elastic.

The centrifugal force while "spinning up" a crucible causes these flakes to form and lap over each other like the scales on a fish, being bound together and held by the clay body.

A well proportioned crucible is made thicker at the bottom, and the sides gradually decrease in thickness toward the top. This formation naturally offers the maximum of resisting power. Crucibles with thinner walls will, of course, conduct heat more rapidly, but are liable earlier to succumb to the strain of heating and handling.

The color of crucibles, why some are dark and others light

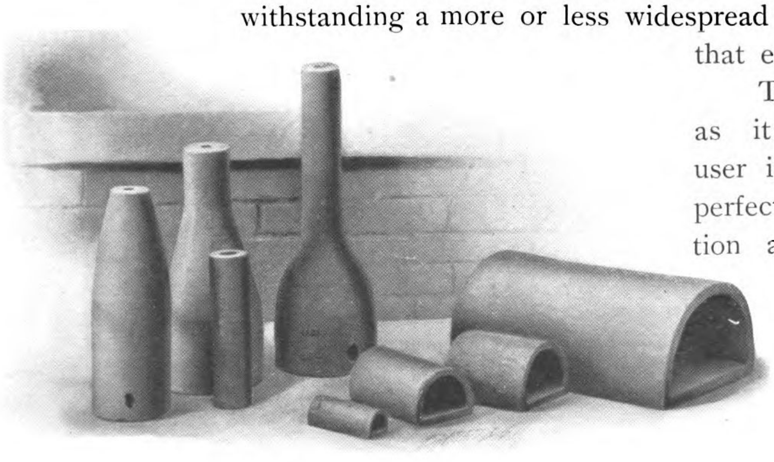
As to the color of finished crucibles, it needs only to be said that while some are darker and some lighter in shade, there is absolutely no difference in quality on account of this difference in color.

The difference in color is the result of an oxidizing condition in the kiln at the time of burning.

To economize space, crucibles are "nested" in the kiln. By "nested" we mean that a smaller one is placed inside a larger one. Even though the outer one does not come in contact with the flame, some air will creep in, due to the expansion and contraction of the kiln walls, and at a certain degree of temperature this air finds its affinity in the carbon, and they both elope in the form of carbonic acid gas—this changes the color of the crucible.

The amount of graphite lost to the crucible by this process of oxidation is only film deep, so trifling, indeed, that it does not in any way impair the quality of the crucible, notwithstanding a more or less widespread impression to that effect.

The crucible as it reaches the user is theoretically perfect in construction and condition. Occasional defects, the



Muffles and Phosphorizer

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A Scalped Crucible

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fault of the crucible maker, must be expected, but in ninety-nine cases out of one hundred it is found that inefficiency in a crucible is due to abuse at one time or another at the hands of the melter.

It is true, it often occurs that from the same "batch" of crucibles one pot will give a phenomenal number of heats while another pot proves very unsatisfactory.

By a "batch" is meant a certain amount of crucible material that has been ground, prepared, weighed and mixed at the same time. From this "batch" some crucibles (No. 400, No. 150, No. 50 and No. 40) are made in the different jiggers. They dry together and finally are baked together in the same kiln and then sent to the customer. Mr. Smith gets some No. 150's and writes and tells us they are the "best ever." Mr. Brown gets some of the same "batch" and he reports them "not so good." Reports from the users of the other sizes confirm Smith's opinion, but all these do not satisfy Brown. His crucibles, he says, are bad and he knows it; he has been in the business a long time, has used many crucibles, and he treated these precisely as he treated former lots, etc.

Scalping—the true cause of a source of much trouble

One source of trouble now and then reported, and most exasperating to the crucible maker, is what is known as "scalping" or flaking-off of a portion of the crucible. This is invariably caused by carelessness at the start.

When the crucible comes from the kiln it contains less than one-quarter of one per cent. combined moisture. In this condition it is absolutely impossible to scalp it, but the moment it cools off it begins to absorb what is known as hygroscopic moisture or the moisture that is in the air, and once absorbed it requires a temperature of not less than 250 degrees Fahrenheit to dispel this moisture. It is also essential that the crucible be kept to this temperature to prevent its absorbing the moisture again.

The user will write to the manufacturer and say: "I kept these crucibles in a hot place." Maybe he did, but not hot enough. He may have had them in a temperature of 150 degrees, but 150 degrees is not high enough to prevent this moisture going into the walls of the crucible, and, while on a very small pot the chances are that no evil results would follow with 150 degrees, it is emphatically true that a large crucible,

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Crucible which ran 61 Heats in a Tilting Furnace

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with its thicker walls, absolutely needs a higher annealing temperature than 150 degrees Fahrenheit. This is due to the fact that the higher heat in the furnace is so sudden that the moisture cannot escape the walls. It quickly becomes steam and expands—pop goes the crucible and you have a miniature steam explosion.

It is, therefore, very important that the crucible should be properly annealed in a temperature of at least 250 degrees Fahrenheit before using.

Concerning a proper method of annealing, there can be no fixed rule as conditions differ, but it is the general practice to anneal on the top of the furnace, although some foundries are equipped with a furnace used exclusively for this annealing purpose, and it is an interesting fact that such foundries never have "scalped" crucibles.

Whether annealing in a special furnace or on top of the crucible furnace, there are four points that must be observed:

First: The temperature must go above 250 degrees Fahrenheit.

Second: This temperature should be reached gradually.

Third: This temperature must be held a sufficient time to allow the moisture to thoroughly disappear.

Fourth: The crucible must go in the crucible furnace with a temperature above 250 degrees Fahrenheit.

For example, with a No. 200 crucible it should take at least ten hours to bring it up to this degree. It should "soak" in the heat fully ten hours and then be charged and go in the furnace at about this heat.

Some foundries practice the first, second and third rules perfectly and "fall down" entirely on the fourth by hurriedly and carelessly taking the crucible from the furnace and placing it on damp sand or a cold furnace floor and allowing it to stand there indefinitely before charging.

A failure to comply with this fourth rule counteracts all that the other three have accomplished and the crucible maker may be informed that his pots are "no good."

It is a mistake to think that after the first three rules are complied with the crucible has had its annealing and is

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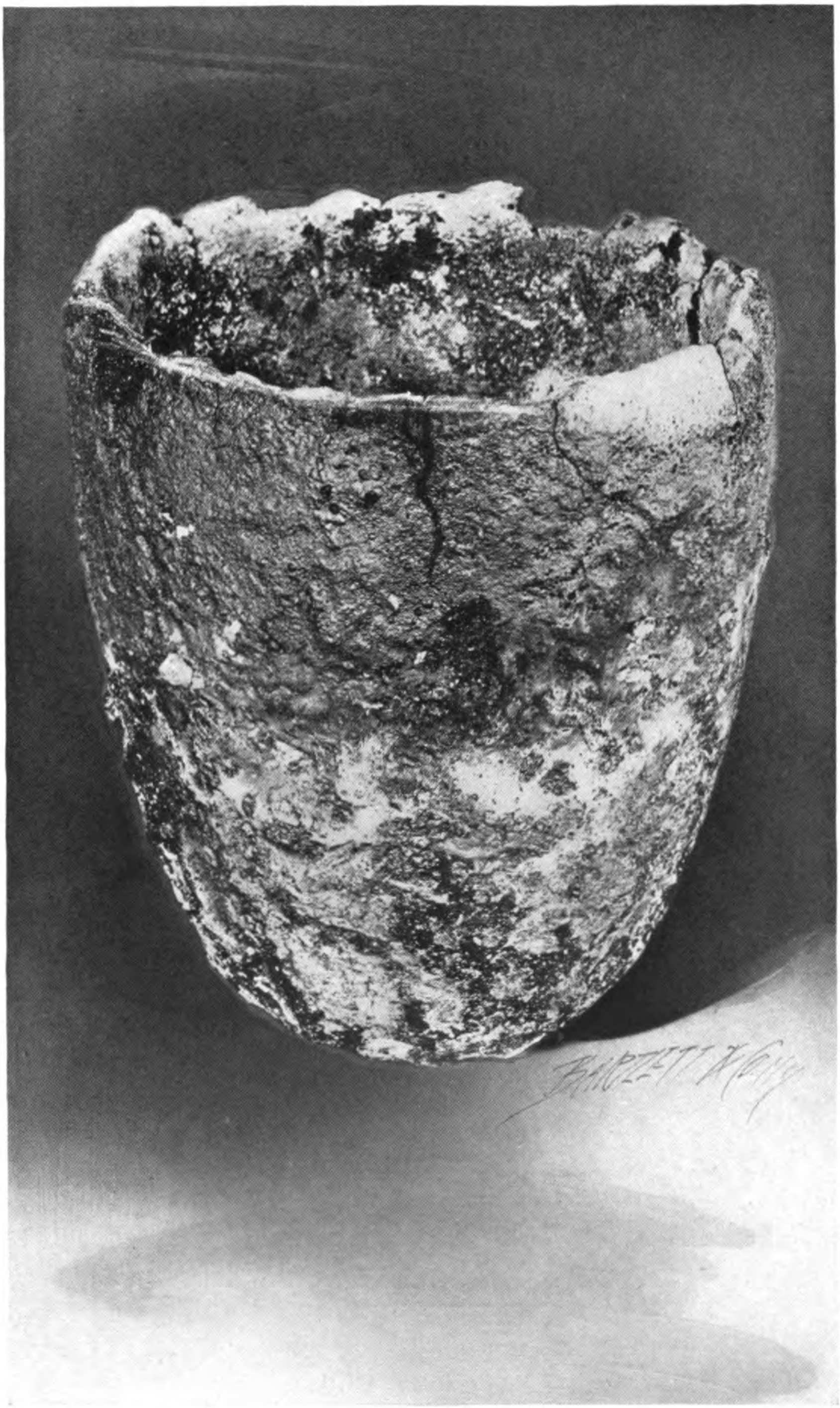

Crucible showing the cracks which begin to form at the top when its life is nearly ended

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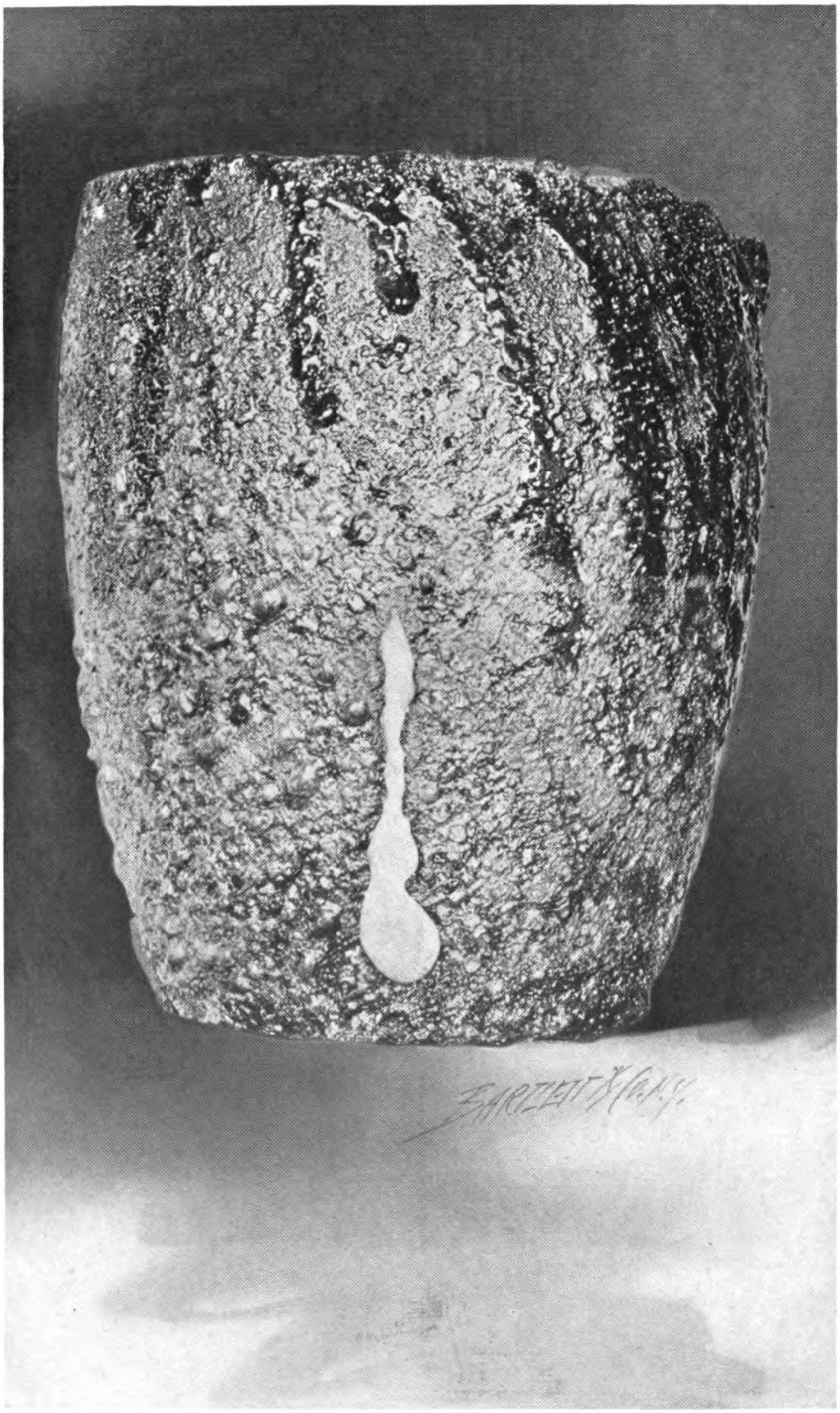

Crucible showing pin-holes from which metal has leaked

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impervious to moisture, for, if allowed to cool below 250 degrees Fahrenheit it will take up moisture a second time just as readily as the first time.

Always keep in mind that the crucible manufacturer has already burned the crucible at a temperature above its calcining point, which is just a little below the melting point of brass.

We have installed in our superintendent's office an elaborate pyrometer system connected with each and every kiln and every part of each kiln; the temperature is thus scientifically measured and automatically recorded. The accuracy of this record is beyond all peradventure.

Alligator cracks

Another defect the crucible manufacturer hears of is what are known as alligator cracks. Now and then a melter finds a crucible with fine cracks all over it, even before it is in the fire. Examination shows the outside covered with hair cracks resembling an alligator's skin. This is due to hot gases and the result of improper annealing.

A crucible is placed on top of the furnace, close to the furnace opening; the furnace lid has been carelessly placed, leaving an opening. Fresh fuel produces more or less gas. Hot gases are always moist, and these gases lick up along the side of the crucible—they moisten the wall—an oxidizing condition develops, and when the heat is sufficiently high the clay body expands and cracks, just the same as a mud pie will crack under the rays of the mid-day sun.

It is generally understood that crucibles improve with age, and this fact explains why it is that the large consumer has little or none of the trouble the small buyer has. One orders in large lots, stores them away and gives them time to "season," while the other does not order until his stock is out, then sends in a "rush" order, and the crucibles go from kiln to furnace.

It is perfectly obvious that he who buys crucibles in quantities, stores them where they will be kept dry and free from all possible moisture, handles them carefully and intelligently, will secure a far greater number of heats than will the man who buys only as he needs and stores or handles his crucibles carelessly.

After a crucible has been properly annealed it will stand a great amount of rough usage, almost abuse, and the danger from

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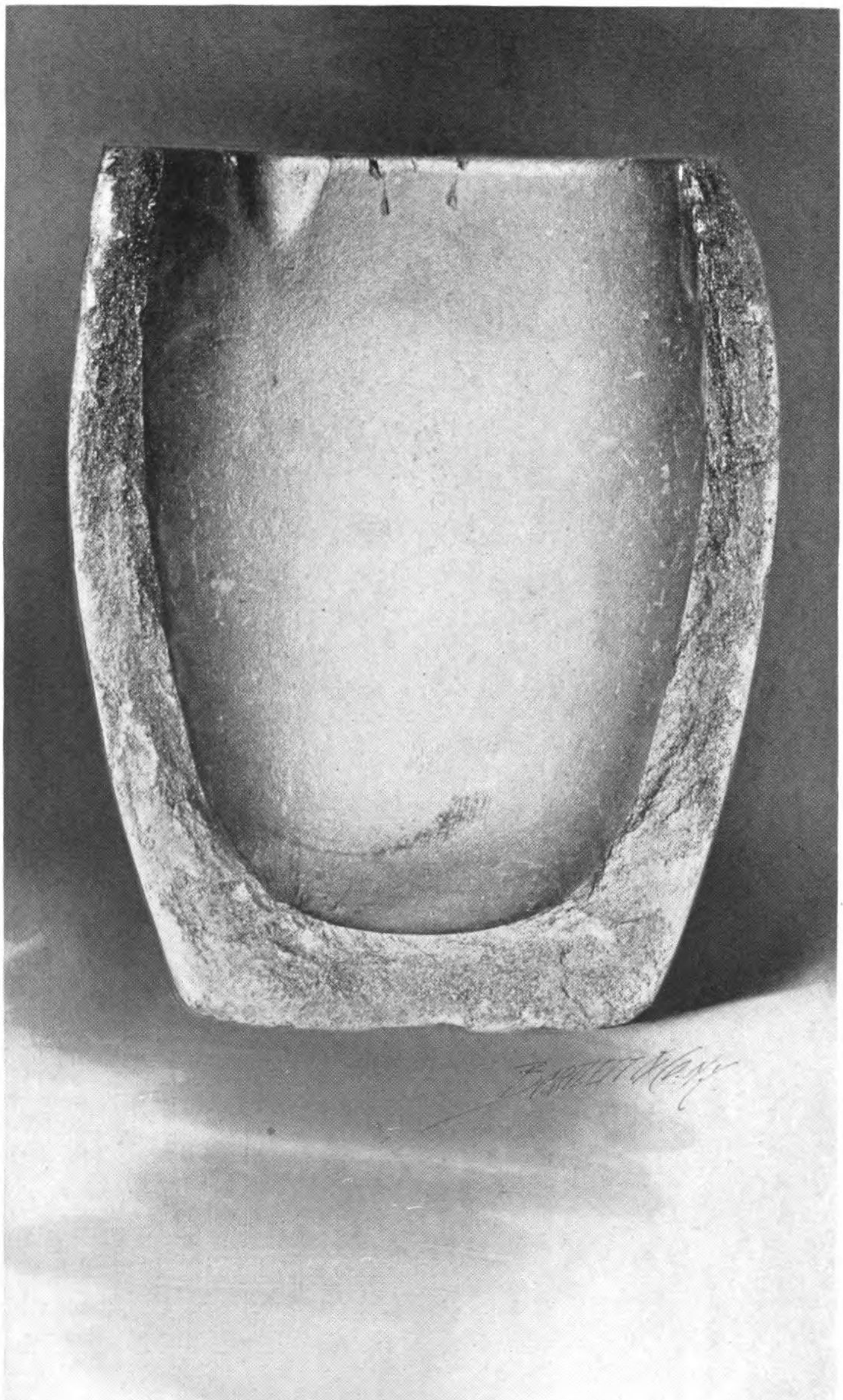

Half of No. 70 Graphite Crucible

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moisture and changing temperature becomes less and less as the crucible grows older.

Pin holes and their cause

Unless the annealing is carefully done, however, hidden cracks, flaws or fissures may be present which, under strong heat, may cause pin holes and similar defects to make their appearance.

Pin holes are one of the chief difficulties that the user of crucibles meets. Crucibles do not usually show this defect until they have been in use for some time. It seems to require a number of heats to develop this defect.

Pin holes are usually discovered by metal dropping down into the furnace pit, and when the crucible is removed a stream of metal will be found trickling down its side.

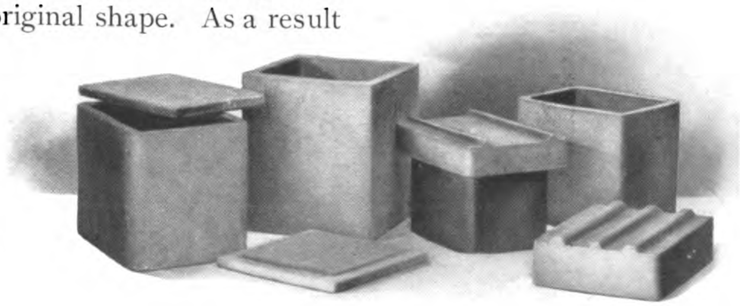
Pin holes are probably small fissures developed either during the drying or the annealing of a crucible, and there seems to be no way of avoiding an occasional defect of this kind.

The use of tongs and their misuse by careless melters

Another cause of the shortness of life of a graphite crucible is the improper fit and careless management of the tongs. This is proved beyond doubt by the fact that in a tilting furnace it is not unusual to obtain from fifty to sixty heats from a No. 200 crucible as against ten or fifteen in a coal or coke furnace where it is necessary to handle the crucible with tongs.

This is natural enough as the one fear of the melter is that the crucible will slip from the tongs while he is lifting it and he therefore takes a good strong grip on it, in fact often driving the ring of the tongs down with a skimmer.

A hot crucible is, of course, plastic, and a strong grip with heavy tongs will squeeze it out of shape. One may think that when in this plastic state simply bending a crucible will not injure it, but you must remember that this is done again and again, bending the crucible into one shape and then back into its original shape. As a result cracks or fissures appear, and the tongs sometimes break pieces out of it. The shape of the crucible



Boxes and Covers used in burning electric light filaments

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Foundry S

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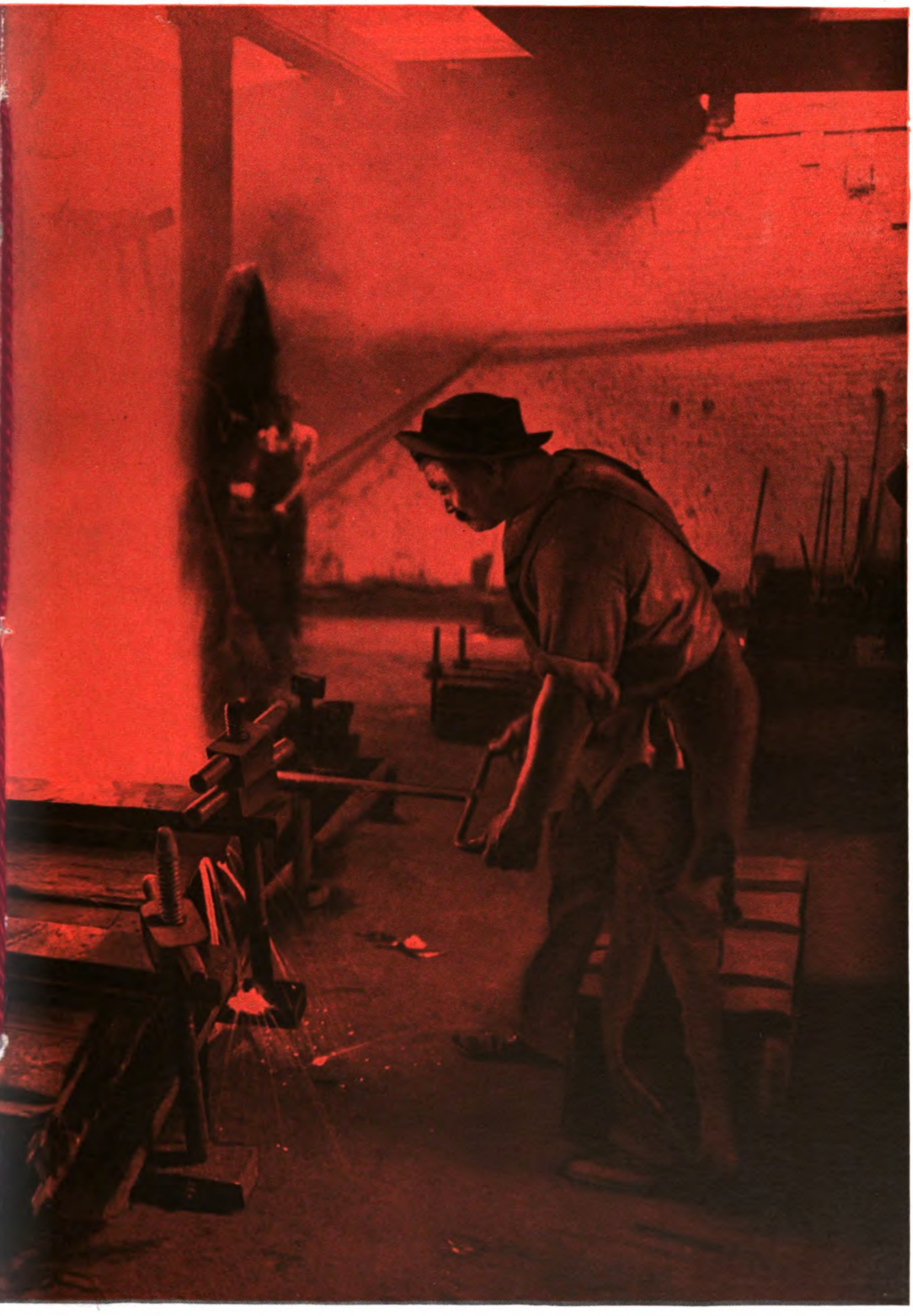

Scene

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Crucible showing the effect of an oil furnace

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tongs is an important matter. The best tongs are those made with jaws shaped like the ace of spades, giving a broad gripping surface, thus enabling the melter to get a good firm hold on the crucible, at the same time distributing the pressure instead of concentrating it at one point.

The tongs which do not grip the crucible with the full pressure of a wide jaw must necessarily injure it. Tongs of the ace of spades shape remove the coal much more easily than ordinary tongs, and they should be made so as to grip the crucible below the bilge, making a heavy squeeze unnecessary.

Every user of crucibles will find that it will pay him well to give careful attention to this question of crucible tongs.

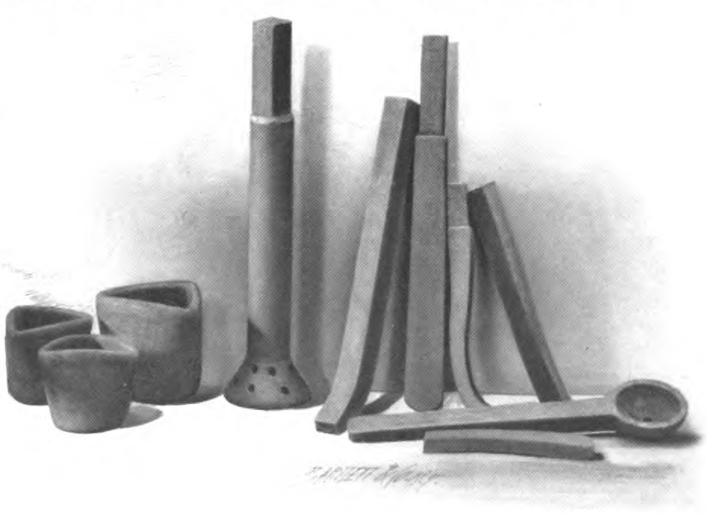
How to place the metal in crucibles

Sufficient time and special care should be exercised in placing the metal in a crucible. It is quite natural to hurry in putting ingots into a crucible in order that the cover of the furnace shall not be left off too long. It is more or less dangerous, however, to jam the ingots, so particular care should be taken to see that they be placed in the crucible loosely.

Graphite is an inert substance, and as graphite is the crucible's principal ingredient, the only expansion possible to a crucible comes from its clay body, hence, if cold ingots are wedged in a crucible and jammed to fit tight, their expansion, which is much greater than the expansion of the crucible, will crack the latter before the melting point is reached.

How to place crucibles in the fire

Crucibles are often unwittingly injured by the furnace man in ramming his fires. As a usual thing, he will take a long steel bar and jam with all his strength into the hot fuel. He does this either to pack the fuel so that more may be added or to make room for the tongs prior to pouring. If, however, it is necessary for any reason to do this it should be done carefully and with judgment,



Stirrers, Dipping Cups and Skimmer

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for a crucible can be ruined very easily through careless ramming of the fuel. Sometimes a clinker or a hard piece of coal sticking to the crucible bottom will, when the crucible with its heavy weight of metal settles down, force a hole into the bottom. A good plan is to use a fire brick on which to rest the crucible. Sometimes the bottom of a worn-out crucible is cut off, turned upside down and used for this purpose.

Fuel, its effect on the life of the crucible

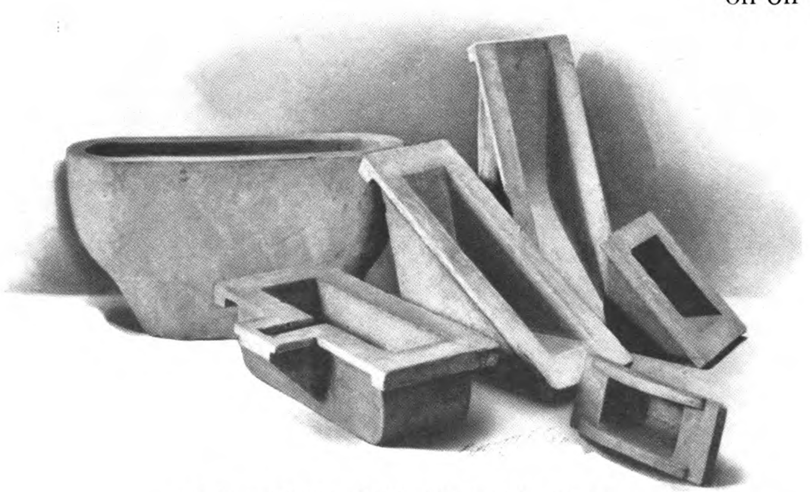
Different kinds of fuel as well as different qualities of the same kind of fuel have great influence on the life of a crucible.

Up to the present time anthracite coal and seventy-two-hour coke have been the principal fuels. Of these two, pure coke is easier on the crucible. The reason for this is that the coke contains less gaseous matter, the gases having been liberated during the process of making the coke.

It is not our purpose to mention any particular brand, but we *know* beyond doubt that there is such a vast difference in this article of fuel that in an actual test, side by side, a difference of over 100 per cent. was realized in the life of the crucible when changed from one coke to another. One was a pure coke while the other was full of sulphur with destructive gases which damaged the crucible to the extent of half its average life.

The manner in which a crucible is affected by these gases is more fully dealt with in the paragraph entitled: "Oil as a fuel."

Natural and artificial gas are used as fuel to quite an extent, and their influence is pointed out in the paragraph on oil burning.



Automobile and Bicycle Brazing Boxes

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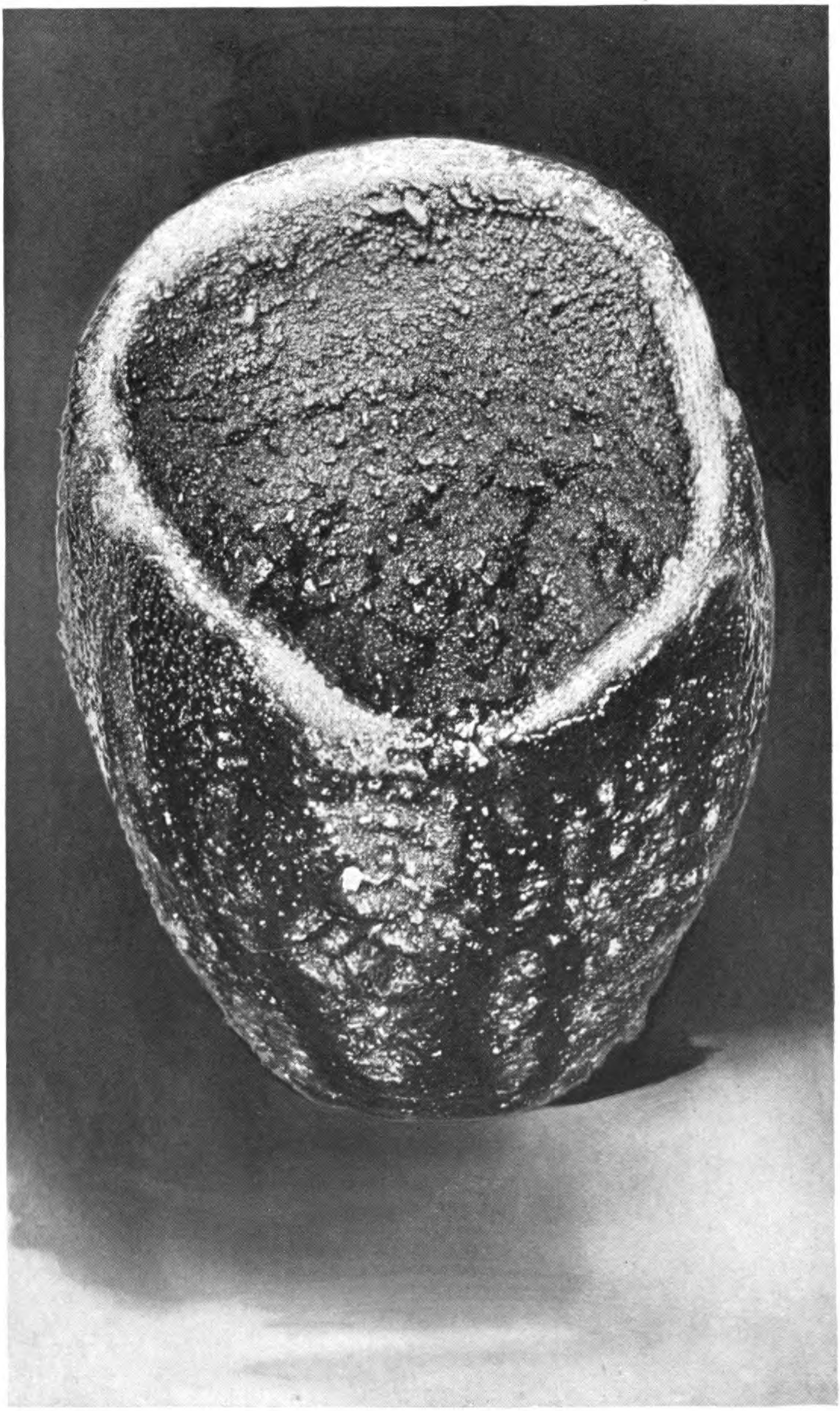

Crucible squeezed out of shape by tongs

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No. 70 Crucible showing effect of squeezing with tongs

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Oil as a fuel, its effect, etc.

There seems only one reason (and this may be a conjecture) why oil used as a fuel should be more troublesome to the crucible than either coal or coke. This reason is that oil fuel produces a much fiercer flame. With coal or coke the flame is more soothing. On the contrary, the oil is doing its work under a pressure of from 60 to 100 pounds. This pressure, even if air alone was used, would in time wear away the crucible just the same as we say that "constant dropping will wear away a stone." Aside from this there seems to be no valid reason against oil, provided it is properly applied and regulated.

When ignition takes place the oil has ceased to be oil—it has vaporized, or in other words, has changed to a gas. This gas forms almost instantly after leaving the injecting nozzle, and it is at this point that it requires careful manipulation.

The chief thing is to produce a perfect combustion, and to do this the operator must understand his business. Too little oil or too much steam (or air) brings about an oxidizing condition which extracts the carbon from the crucible wall, leaving a porous clay structure, and, while the wall may retain its original thickness, the graphite, its principal vital ingredient, having been taken away, the crucible is ready to crack.

With too much oil and too little steam (or air) it is impossible to procure a perfect combustion, with the result that the surplus gas which is not consumed will as a hot gas envelop the crucible. It not only oxidizes to a certain extent but the hot gas contains moisture and this produces what are termed " alligator cracks," and layers will peel from the crucible wall to the depth this moisture has penetrated. In fact, the effect of this hot gas permeates the entire wall with the result of deadening it. Its vitality is gone, and it may be compared to timber from a tree whose sap has been extracted before cutting. The wood looks the same ; it works the same under the tool, but the life is gone and its strength impaired—it is known to the lumber trade as " brash " timber.

A crucible can be made " brash " in regular foundry work just the same as in an oil furnace, the *cause* that produces this *effect* is precisely the same.

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In conclusion

In conclusion we would say, as we said in the beginning, that the object of this booklet is simply to correct the bad practises that shorten the life of a crucible.

It is a pleasure to say as a last word that such practises are not at all general; it is only now and then that we hear of them, but, even few as they are, we will feel that our time has been well spent should our efforts help every crucible user to score his full number of meltings with every crucible.

ALLOYS

NOTE.—*A* = Antimony, *B* = Bismuth, *C* = Copper, *G* = Gold, *I* = Iron, *L* = Lead, *N* = Nickel, *S* = Silver, *T* = Tin, *Z* = Zinc.

Name	Proportions
Brass, common yellow	2 *C*, 1 *Z*
Brass, to be rolled	32 *C*, 10 *Z*, 1.5 *T*
Brass castings, common	20 *C*, 1.25 *Z*, 2.5 *T*
Brass castings, hard	25 *C*, 2 *Z*, 4.5 *T*
Brass propellers	8 *C*, .5 *Z*, 1 *T*
Gun metal	8 *C*, 1 *T*
Copper flanges	9 *C*, 1 *Z*, .26 *T*
Muntz's metal	6 *C*, 4 *Z*
Statuary	91.4 *C*, 5.53 *Z*, 1.7 *T*, 1.37 *L*
German silver	2 *C*, 7.9 *N*, 6.3 *Z*, 6.5 *I*
Britannia metal	50 *A*, 25 *T*, 25 *B*
Chinese silver	65.1 *C*, 19.3 *Z*, 13 *N*, 2.58 *S*, 12 *I*
Chinese white copper	20.2 *C*, 12.7 *Z*, 1.3 *T*, 15.8 *N*
Medals	100 *C*, 8 *Z*
Pinchbeck	5 *C*, 1 *Z*
Babbitt's metal	25 *T*, 2 *A*, .5 *C*
Bell metal, large	3 *C*, 1 *T*
Bell metal, small	4 *C*, 1 *T*
Chinese gongs	40.5 *C*, 9.2 *T*
Telescope mirrors	33.3 *C*, 16.7 *T*
White metal, ordinary	3.7 *C*, 3.7 *Z*, 14.2 *T*, 28.4 *A*
White metal, hard	35 *C*, 13 *Z*, 2.2 *T*
Sheeting metal	56 *C*, 45 *Z*, 12 arsenic
Metal, expands in cooling	75 *L*, 16.7 *A*, 8.3 *B*

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FREEZING, FUSING, AND BOILING POINTS

Substances	Fahrenheit Degrees	Centigrade Degrees	Reaumur Degrees
Bromine freezes at	— 7.6	—22	—17.6
Olive oil freezes at	50	10	8
Quicksilver freezes at	—39	—39.4	—31.5
Water freezes at	32	0	0
Bismuth metal fuses at	507	264	211
Copper fuses at	2200	1204	963
Gold fuses at	2518	1380	1105
Iron fuses at	2800	1538	1230
Lead fuses at	617	325	260
Potassium fuses at	144.5	62.5	50
Silver fuses at	1832	1000	800
Sodium fuses at	204	95.6	76.5
Sulphur fuses at	239	115	92
Tin fuses at	442	228	182
Zinc fuses at	773	412	329.6
Alcohol boils at	167	74.4	63
Bromine boils at	145	63	50
Ether boils at	96	35.5	28.4
Iodine boils at	347	175	140
Water boils at	212	100	80

SPECIFIC GRAVITY

Name of Substance	Specific Gravity	Name of Substance	Specific Gravity
Metals		Stones and Earth	
Platinum, rolled	22.009	Salt, common	2.130
Gold, 22 carats fine	17.486	Saltpeter	2.090
Lead, pure	11.330	Sulphur, native	2.033
Silver, pure	10.474	Common soil	1.984
Copper, wire and rolled	8.878	Clay	1.900
Copper, pure	8.788	Brick	2.000
Bronze, gun metal	8.500	Sand	2.650
Brass, common	8.500	Lime, quick	1.500
Steel, cast steel	7.919	Charcoal	.441
Steel, common soft	7.833		
Steel, hard'ed and temp'd	7.818	Liquids	
Iron, pure	7.768	Alcohol, pure	.792
Iron, wrought and rolled	7.780	Oil, linseed	.940
Iron, hammered	7.789	Oil, turpentine	.870
Iron, cast	7.207	Water, distilled (62.425 lb. per cu. ft.)	1.000
Tin, English	7.201	Water, sea	1.030
Zinc, rolled	7.101		
Antimony	6.712	Gases and Vapors	
Stones and Earth		Ammonia gas	.5894
Glass, flint	3.500	Carbonic acid	1.5201
Glass, bottle	2.732	Light carbureted hydrogen	.5527
Marble, common	2.686	Oxygen	1.1056
Slate	2.800	Sulphureted hydrogen	1.1747
Stone, common	2.520	Steam at 212° F.	.4880

The specific gravity of a body is the ratio between its weight and the weight of a like volume of distilled water at a temperature of 39.2° F. For gases, air is taken as the unit. One cubic foot of water at 39.2° F. weighs 62.425 pounds.

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THE METRIC SYSTEM—MEASURES OF CAPACITY

Metric Denominations and Values			Equivalents in Denominations in Use	
Names	Number of Litres	Cubic Measure	Dry Measure	Liquid or Wine Measure
Kilolitre or stere	1000	1 cubic metre	1.308 cubic yards	264.17 gallons
Hectolitre	100	$\frac{1}{10}$ of a cubic metre	2 bushels and 3.35 pecks	26.417 gallons
Dekalitre	10	10 cubic decimetres	9.08 quarts	2.6417 gallons
Litre	1	1 cubic decimetre	0.908 quart	1.0567 quarts
Decilitre	$\frac{1}{10}$	$\frac{1}{10}$ of a cubic decimetre	6.1022 cubic inches	0.845 gill
Centilitre	$\frac{1}{100}$	10 cubic centimetres	0.6102 cubic inch	0.338 fluid ounce
Millilitre	$\frac{1}{1000}$	1 cubic centimetre	0.061 cubic inch	0.27 fluid dram

WEIGHTS

Metric Denominations and Values			Equivalents in Denominations in Use
Names	Number of Grams	Weight of What Quantity of Water at Maximum Density	Avoirdupois Weight
Miller or tonneau	1000000	1 cubic metre	2204.6 pounds
Quintal	100000	1 hectolitre	220.46 pounds
Myriagram	10000	10 litres	22.046 pounds
Kilogram or kilo	1000	1 litre	2.2046 pounds
Hectogram	100	1 decilitre	3.5274 ounces
Dekagram	10	10 cubic centimetres	0.3527 ounce
Gram	1	1 cubic centimetre	15.432 grains
Decigram	$\frac{1}{10}$	$\frac{1}{10}$ of a cubic centimetre	1.5432 grains
Centigram	$\frac{1}{100}$	10 cubic millimetres	0.1543 grain
Milligram	$\frac{1}{1000}$	1 cubic millimetre	0.0154 grain

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MONTHLY WAGE TABLE*

	$10	$11	$12	$13	$14	$15	$16	$17	$18	$19	$20
1 day	.38	.42	.46	.50	.54	.58	.62	.65	.69	.73	.77
2 days	.77	.85	.92	1.00	1.08	1.15	1.23	1.31	1.38	1.46	1.54
3 days	1.15	1.27	1.38	1.50	1.62	1.73	1.85	1.96	2.08	2.19	2.31
4 days	1.54	1.69	1.85	2.00	2.15	2.31	2.46	2.62	2.77	2.92	3.08
5 days	1.92	2.12	2.31	2.50	2.69	2.88	3.08	3.27	3.46	3.65	3.85
6 days	2.31	2.54	2.77	3.00	3.23	3.46	3.69	3.92	4.15	4.38	4.62
7 days	2.69	2.96	3.23	3.50	3.77	4.04	4.31	4.58	4.85	5.12	5.38
8 days	3.08	3.38	3.69	4.00	4.31	4.62	4.92	5.23	5.54	5.85	6.15
9 days	3.46	3.81	4.15	4.50	4.85	5.19	5.54	5.88	6.23	6.58	6.92
10 days	3.85	4.23	4.62	5.00	5.38	5.77	6.15	6.54	6.92	7.31	7.69
11 days	4.23	4.65	5.08	5.50	5.92	6.35	6.77	7.19	7.62	8.04	8.46
12 days	4.62	5.08	5.44	6.00	6.46	6.92	7.38	7.85	8.31	8.77	9.23
13 days	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00
14 days	5.38	5.92	6.46	7.00	7.54	8.08	8.62	9.15	9.69	10.23	10.77
15 days	5.77	6.35	6.92	7.50	8.08	8.65	9.23	9.81	10.38	10.96	11.54
20 days	7.69	8.46	9.23	10.00	10.77	11.54	12.31	13.03	13.85	14.62	15.38
1 month	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00
2 months	20.00	22.00	24.00	26.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00
3 months	30.00	33.00	36.00	39.00	42.00	45.00	48.00	51.00	54.00	57.00	60.00
4 months	40.00	44.00	48.00	52.00	56.00	60.00	64.00	68.00	72.00	76.00	80.00
5 months	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00
6 months	60.00	66.00	72.00	78.00	84.00	90.00	96.00	102.00	108.00	114.00	120.00
7 months	70.00	77.00	84.00	91.00	98.00	105.00	112.00	119.00	126.00	133.00	140.00
8 months	80.00	88.00	96.00	104.00	112.00	120.00	128.00	136.00	144.00	152.00	160.00
9 months	90.00	99.00	108.00	117.00	126.00	135.00	144.00	153.00	162.00	171.00	180.00
10 months	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00
11 months	110.00	121.00	132.00	143.00	154.00	165.00	176.00	187.00	198.00	209.00	220.00
1 year	120.00	132.00	144.00	156.00	168 00	180.00	192.00	204.00	216.00	228.00	240.00

* Six working days in the week.

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Showing influence of oil blast trained on the retort direct

HELP IN CASE OF ACCIDENTS

Drowning. 1. Loosen clothing if any.

2. Empty lungs of water by laying body on its stomach, and lifting it by the middle so that the head hangs down. Jerk the body a few times.

3. Pull tongue forward, using handkerchief, or pin with string, if necessary.

4. Imitate motion of respiration by alternately compressing and expanding the lower ribs, about twenty times a minute. Alternately raising and lowering the arms from the sides up above the head will stimulate the action of the lungs. Let it be done gently but persistently.

5. Apply warmth and friction to extremities.

6. By holding tongue forward, closing the nostrils, and pressing the "Adam's apple" back (so as to close entrance to stomach), direct inflation may be tried. Take a deep breath

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and breathe it forcibly into the mouth of patient, compress the chest to expel the air, and repeat the operation.

7. *Don't give up!* People have been saved after hours of patient, vigorous effort.

8. When breathing begins, get patient into a warm bed, give warm drinks, or spirits in teaspoonfuls, fresh air and quiet.

BURNS AND SCALDS. Cover with cooking soda and lay wet cloths over it. Whites of eggs and olive oil. Olive oil or linseed oil, plain, or mixed with chalk or whiting. Sweet or olive oil and lime water.

LIGHTNING. Dash cold water over a person struck.

SUNSTROKE. Loosen clothing. Get patient into shade and apply ice-cold water to head. Keep head in elevated position.

MAD DOG OR SNAKE BITE. Tie cord tight above wound. Suck the wound and cauterize with caustic or white-hot iron at once, or cut out adjoining parts with a sharp knife. Give stimulants, as whiskey, brandy, etc.

STINGS OF VENOMOUS INSECTS, ETC. Apply weak ammonia, oil, salt water, or iodine.

FAINTING. Place flat on back; allow fresh air and sprinkle with water. Place head lower than rest of body.

TESTS OF DEATH. Hold mirror to mouth. If living, moisture will gather. Push pin into flesh. If dead the hole will remain, if alive it will close up. Place fingers in front of a strong light. If alive, they will appear red; if dead, black or dark. If a person is dead decomposition is almost sure to set

Stopper and Nozzles used in open hearth stove works

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in after 72 hours have elapsed. If it does not, then there is room for investigation by the physician. Do not permit burial of dead until some certain indication of death is apparent.

CINDERS IN THE EYE. Roll soft paper up like a lamplighter, and wet the tip to remove, or use a medicine dropper to draw it out. Rub the *other* eye.

FIRE IN ONE'S CLOTHING. *Don't run*—especially not downstairs or out-of-doors. Roll on carpet, or wrap in woolen rug or blanket. Keep the head down, so as not to inhale flame.

FIRE FROM KEROSENE. *Don't use water*, it will spread the flames. Dirt, sand or flour is the best extinguisher, or smother with woolen rug, tablecloth, or carpet.

SUFFOCATION FROM INHALING ILLUMINATING GAS. Get into the fresh air as soon as possible and lie down. Keep warm. Take ammonia—twenty drops to a tumbler of water, at frequent intervals; also, two to four drops tincture of nux vomica every hour or two for five or six hours.

RULES IN CASE OF FIRE

Crawl on the floor. The clearest air is the lowest in the room. Cover head with woolen wrap, wet if possible. Cut holes for the eyes. *Don't get excited.*

Ex-Chief Hugh Bonner, of the New York Fire Department, gives the following rules applying to houses, flats, hotels, etc.:

Familiarize yourself with the location of hall windows and natural escapes. Learn the location of exits to roofs of adjoining buildings. Learn the position of all stairways, particularly the top landing and scuttle to the roof. Should you hear cry of "fire," and columns of smoke fill the rooms, above all *keep cool.* Keep the doors of rooms shut. Open windows from the top. Wet a towel, stuff it in the mouth, breathe through it instead of nose, so as not to inhale smoke. Stand at window and get benefit of outside air. If room fills with smoke keep close to floor and crawl along by the wall to the window.

Do not jump unless the blaze behind is scorching you. Do not even then if the firemen with scaling ladders are coming up the building or are near. Never go to the roof, unless as a last

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resort and you know there is escape from it to adjoining buildings. In big buildings fire always goes to the top. Do not jump through flame within a building without first covering the head with a blanket or heavy clothing and gauging the distance. Don't get excited; try to recall the means of exit, and if any firemen are in sight *don't jump.*

If the doors of each apartment, especially in the lower part of the house, were closed every night before the occupants retired there would not be such a rapid spread of flames.

CAPACITY OF BOXES

The following table will often be found convenient, taking inside dimensions:

A box 8 2/5 inches by 8 inches and 8 inches deep, will contain a peck.

A box 8 inches square and 4 1/8 inches deep, will contain a gallon.

A box 7 inches square and 2 3/4 inches deep, will contain a half gallon.

A box 4 inches square and 4 1/5 inches deep, will contain a quart.

A box 3 inches square and 3 2/3 inches deep, will contain a pint.

A box 24 inches by 17 inches and 28 inches deep, will contain a barrel.

A box 18 inches by 15 1/2 inches and 8 inches deep, will contain a bushel.

A box 13 1/2 inches square and 11 1/4 inches deep, will contain a bushel.

A box 12 inches by 11 1/2 inches and 9 inches deep, will contain a half bushel.

A box 10 inches square and 10 3/4 inches deep, will contain a half bushel.

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WEIGHTS AND MEASURES

APOTHECARIES' WEIGHT

20 grains	1 scruple			
60 grains or	3 scruples	1 dram		
480 grains or	24 scruples or	8 drams	1 ounce	
5760 grains or	288 scruples or	96 drams or	12 ounces,	1 pound

AVOIRDUPOIS WEIGHT

$27\frac{11}{32}$ grains	1 dram		
$437\frac{1}{2}$ grains or	16 drams	1 ounce	
7000 grains or	256 drams or	16 ounces	1 pound
25 pounds			1 quarter
4 quarters			1 cwt.
20 cwt.			1 ton

LONG MEASURE

12 inches	1 foot		
36 inches or	3 feet	1 yard	
198 inches or	$16\frac{1}{2}$ feet or	$5\frac{1}{2}$ yards	1 rod or pole
40 rods			1 furlong
8 furlongs			1 statute mile (1760 yards or 5280 feet)
3 miles			1 league

SQUARE MEASURE

144 inches	1 sq. ft.		
1296 inches or	9 sq. ft.	1 sq. yd.	
39204 inches or	$274\frac{1}{4}$ sq. ft. or	$30\frac{1}{4}$ sq. yds.	1 sq. rod or perch
40 square rods			1 rood
4 roods			1 acre
640 acres			1 square mile
36 square miles (6 miles square)			1 township

CUBIC MEASURE

1728 cubic inches	1 cubic foot	
46656 cubic inches or	27 cubic feet	1 cubic yard
128 cubic feet		1 cord
$24\frac{3}{4}$ cubic feet		1 perch

DRY MEASURE

2 pints	1 quart		
16 pints or	8 quarts	1 peck	
64 pints or	32 quarts or	4 pecks	1 bushel

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LIQUID MEASURE

4 gills	1 pint		
8 gills or 2 pints	1 quart		
32 gills or 8 pints or 4 quarts		. . . . .	1 gallon
31½ gallons		. . . .	1 barrel
2 barrels or 63 gallons		. . . . . .	1 hogshead

LINE SHAFTING

The speed of the shaft is fixed largely by the speed of the driving belt or the diameters of the pulleys upon it. In general, machine shop shafts run about 120 to 150 revolutions per minute; shafts driving wood-working machinery, about 200 to 250 revolutions per minute; in cotton mills, the practice is to make the shaft diameter smaller and run at a higher speed. Line shafts should generally not be less than 1¾ inches in diameter.

The distance between the bearings should not be great enough to permit a deflection of more than $\frac{1}{100}$ of an inch per foot of length; hence, the bearings must be closer when the shaft is heavily loaded with pulleys.

The maximum distances between bearings of different sizes of continuous shafts used for transmitting power are:

DISTANCES BETWEEN BEARINGS

Diameter of Shaft Inches	Distances Between Bearings in Feet	
	Wrought-iron Shaft	Steel Shaft
2	11	11.50
3	13	13.75
4	15	15.75
5	17	18.25
6	19	20.00
7	21	22.25
8	23	24.00
9	25	26.00

Pulleys that give out a large amount of power should be placed as near a hanger as possible.

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THE VALUE OF FUELS

CALCULATED IN BRITISH THERMAL UNITS BY PROF. VIVIAN B. LEWES, LONDON

A British thermal heat unit (B. T. U.) is that quantity of heat required to raise one pound of pure water one degree Fahrenheit at or about 39.1 degrees Fahrenheit.

	Cost per million B. T. U.
Gas, 650 units per foot	\$1 54
Oil, 150,000 units per gallon . . .	66
Soft coal, 30,000,000 units per ton . .	$13\frac{3}{10}$
Hard coal, 27,000,000 units per ton . .	$29\frac{6}{10}$

These figures are based on gas at \$1.00 per thousand feet; oil at 10 cents per gallon; soft coal at \$4.00 per ton, and hard coal at \$8.00 per ton.

Effect of the direct training of flame
with oil as a fuel

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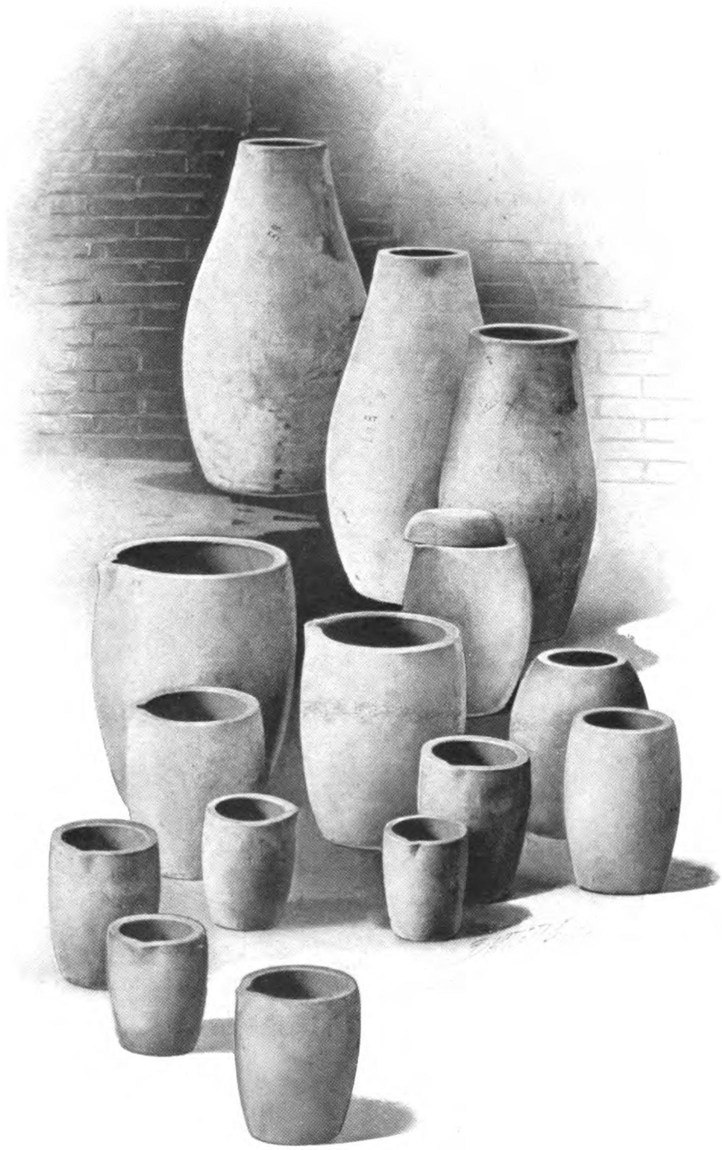

Regular Crucibles and Retorts

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